Patent Claims

1. A pulse modulator for conversion of a complex input signal $(x(t))$ to a pulsed signal $(y(t))$, **characterized by**

- a subtraction stage (1) which produces a control error signal from the difference between the complex input signal $(x(t))$ and a feedback signal (2),
- a single conversion stage, which converts the control error signal to a control signal (7);
- a first multiplication stage (8), which multiplies the control signal (7) by a complex mixing signal oscillating at the frequency ω_0, and thus produces at least one of a real part (11) and an imaginary part of a control signal which has been up-mixed by ω_0;
- a quantization stage (12), which quantizes at least one of the real part and imaginary part of the control signal which has been up-mixed by ω_0 and thus produces the pulsed signal $(y(t))$;
- a feedback unit, which uses the pulsed signal $(y(t))$ to produce the feedback signal (2) for the subtraction stage.

2. The pulse modulator as claimed in claim 1, **characterized** in that the pulse modulator has an in-phase signal path for processing of the real part of the input signal, as well as a quadrature signal path for processing of the imaginary part of the input signal.

3. The pulse modulator as claimed in claim 1 or 2, **characterized** in that the control error signal, the control signal and the feedback signal are each complex signals, which each have a real signal component as well as an imaginary signal component.

4. The pulse modulator as claimed in one of the preceding claims, **characterized** in that the signal

conversion stage has an integrator stage which integrates the control error signal and produces an integrated signal as the control signal.

5. The pulse modulator as claimed in claim 4, **characterized** in that the integrator stage has a first integrator for the in-phase signal path (14) and a second integrator for the quadrature signal path (15), with the first integrator integrating the real part of the control error signal, and with the second integrator integrating the imaginary part of the control error signal.

6. The pulse modulator as claimed in one of the preceding claims, **characterized** in that the signal conversion stage has an amplifier stage (6).

7. The pulse modulator as claimed in one of the preceding claims, **characterized** in that the first multiplication stage has a first multiplier (23) for the in-phase signal path and a second multiplier (33) for the quadrature signal path, with the first multiplier multiplying the real part (22) of the control signal by the real part of the complex mixing signal oscillating at the frequency ω_0, and thus producing a first result signal (24), and with the second multiplier (33) multiplying the imaginary part (32) of the control signal by the imaginary part of the complex mixing signal oscillating at the frequency ω_0, and thus producing a second result signal (34).

8. The pulse modulator as claimed in claim 7, **characterized by** an adder (25) which adds the first result signal (24) from the first multiplier and the second result signal (34) from the second multiplier to form a sum signal (35) in order to determine the real part of the up-mixed control signal.

9. The pulse modulator as claimed in claim 8,

characterized in that the quantization stage quantizes the sum signal produced by the adder.

10. The pulse modulator as claimed in one of the preceding claims, **characterized** in that a noise level is added to the input signal to the quantization stage.

11. The pulse modulator as claimed in one of the preceding claims, **characterized** in that the quantization stage carries out binary quantization or ternary quantization of its respective input signal.

12. The pulse modulator as claimed in one of the preceding claims, **characterized** in that the feedback unit has a second multiplication stage (13), which multiplies the pulsed signal by a complex-conjugate mixing signal oscillating at the frequency ω_0, and thus produces the feedback signal (2) down-mixed by ω_0, for the subtractor.

13. The pulse modulator as claimed in claim 12, **characterized** in that the second multiplication stage has a third multiplier (37) for production of the real part (17) of the feedback signal and has a fourth multiplier (38) for production of the imaginary part (27) of the feedback signal, with the third multiplier (37) multiplying the pulsed signal by the real part of the complex-conjugate mixing signal oscillating at the frequency ω_0, and with the fourth multiplier (38) multiplying the pulsed signal by the imaginary part of the complex-conjugate mixing signal at the frequency ω_0.

14. The pulse modulator as claimed in one of the preceding claims, **characterized** in that the pulse modulator is operated at a sampling frequency ω_A which is 2 to 1000 times higher than the mixing frequency ω_0.

15. The pulse modulator as claimed in one of the

preceding claims, **characterized** in that the pulse modulator is implemented with the aid of a digital signal processor.

16. A drive circuit for a micromechanical resonator which has at least one pulse modulator as claimed in one of claims 1 to 15.

17. The drive circuit as claimed in claim 16, **characterized** in that the pulsed signal which is produced by the at least one pulse modulator is used for electrostatic oscillation stimulation of the resonator.

18. The drive circuit as claimed in claim 16 or 17, **characterized** in that the mixing frequency ω_0 of the pulsed modulator corresponds to one resonant frequency of the resonator.

19. A frequency generator for synthesis of a pulsed signal at a predetermined frequency and with a predetermined phase, which has at least one pulse modulator as claimed in one of claims 1 to 15.

20. The frequency generator as claimed in claim 19 or 20, **characterized** in that the pulse modulator is followed by a bandpass filter, preferably a crystal or ceramic filter.

21. A method for pulse modulation of a complex input signal, **characterized by** the following steps:

- production of a control error signal from the difference between the complex input signal (x(t)) and a feedback signal (2);
- conversion of the control error signal to a control signal (7);
- multiplication of the control signal (7) by a complex mixing signal oscillating at the frequency ω_0, with at least one of the real part (11) and

imaginary part of a control signal, up-mixed by ω_0, being produced;

- quantization of at least one of the real part (11) and imaginary part of the control signal, up-mixed by ω_0, in order to produce a pulsed signal (y(t));
- production of the feedback signal (2) from the pulsed signal (y(t)).

22. The method as claimed in claim 21, **characterized** in that the control error signal, the control signal and the feedback signal are each complex signals, which each have a real signal component as well as an imaginary signal component.

23. The method as claimed in claim 21 or claim 22, **characterized** in that the control error signal is converted to the control signal by integrating the control error signal.

24. The method as claimed in one of claims 21 to 23, **characterized** in that the real part of the control signal is multiplied by the real part of the complex mixing signal oscillating at the frequency ω_0, and a first result signal is thus produced, and in that the imaginary part of the control signal is multiplied by the imaginary part of the complex mixing signal oscillating at the frequency ω_0, and a second result signal is thus produced.

25. The method as claimed in claim 24, **characterized** in that the first result signal and the second result signal are added to form a sum signal in order to determine the real part of the up-mixed control signal.

26. The method as claimed in claim 25, **characterized** in that the sum signal is quantized in order to produce the pulsed signal.

27. The method as claimed in one of claims 21 to 26,

characterized in that a noise level is added before the quantization of at least one of the real part and imaginary part of the control signal up-mixed by ω_0.

28. The method as claimed in one of claims 21 to 27, **characterized** in that the feedback signal is produced by multiplying the pulsed signal by a complex-conjugate mixing signal oscillating at the frequency ω_0.

29. The method as claimed in one of claims 21 to 28, **characterized** in that the pulsed signal is used for electrostatic oscillation stimulation of a micromechanical resonator.

30. The method as claimed in claim 29, **characterized** in that the mixing frequency ω_0 corresponds to one resonant frequency of the micromechanical resonator.

31. A computer program product, which has means for carrying out the method steps as claimed in one of claims 21 to 30 on a computer, a digital signal processor or the like.